

REMARKS/ARGUMENTS

Claims 92, 97, 99, 101, 104, 106 to 109, 118, 120 to 123, 125 to 129, 151, 152, 154 and 156 to 172 are pending in the application, of which Claims 92, 120, 151, 166 and 169 are the independent claims. Claims 92, 120, 122 and 151 are amended, and new Claims 166 to 172 are added herein. No new matter is believed to be added by the claim amendments herein. Reconsideration and further examination are respectfully requested.

Claim Rejections – 35 USC § 103

Claims 92, 97, 101, 104, 106, 107, 109, 118, 120 to 123, 126 to 129 and 163 were rejected under 35 U.S.C. § 103(a) over U.S. Pat. No. 6,013,571 (“Morrell”), U.S. Pat. No. 6,459,150 (“Wu”) and U.S. Pub. No. 2002/0033525 (“Ohuchi”). Claims 99 and 165 were rejected under 35 U.S.C. § 103(a) over Morrell, Wu, Ohuchi and U.S. Pub. No. 2002/0079575 (“Hozoji”). Claims 108 and 125 were rejected under 35 U.S.C. § 103(a) over Morrell, Wu, Ohuchi and U.S. Pub. No. 2002/0095784 (“Fang”). Claims 151, 152, 154, 157, 159 to 162 and 164 were rejected under 35 U.S.C. § 103(a) over Morrell. Claim 156 was rejected under 35 U.S.C. § 103(a) over Morrell and Fang. Claim 158 was rejected under 35 U.S.C. § 103(a) over Morrell and Hozoji. Claim 161 was rejected under 35 U.S.C. § 103(a) over Morrell and Ohuchi. Reconsideration and withdrawal of these rejections are respectfully requested.

Claim 92

Claim 92 is directed to a chip package. A substrate comprising a first pad has a surface with a first region, a second region and a third region between said first and second regions, and a solder mask layer on said first and second regions, wherein a first opening in said solder mask layer is over said third region, and said third region is at a bottom of said first opening. A silicon chip is over said substrate, wherein said silicon chip comprises a second pad having a surface with a fourth region, a fifth region and a sixth region between said fourth and fifth regions and over said third region, and a separating layer on said fourth and fifth regions, wherein a second opening in said separating layer is under said sixth region, and said sixth region is at a top of said second opening. A copper pillar is between said third region and said sixth region, wherein said copper pillar is connected to said third region through said first opening, and wherein said copper

pillar is connected to said sixth region through said second opening, wherein said second pad is connected to said first pad through said copper pillar. A metal layer is between said copper pillar and said sixth region, between said copper pillar and said separating layer, between said copper pillar and said fourth region, and between said copper pillar and said fifth region, wherein said copper pillar is connected to said sixth region through said metal layer. A tin-containing layer is between said copper pillar and said third region, wherein said copper pillar is connected to said third region through said tin-containing layer, wherein said tin-containing layer comprises silver, wherein said copper pillar has a thickness greater than a vertical distance between said copper pillar and said third region.

Applicants respectfully submit that the applied references, either alone or in combination, are not seen to disclose or suggest the foregoing features of amended Claim 92.

In this regard, the Office Action concedes that Morrell does not teach or suggest a solder mask and a tin cap comprising silver or copper. *See*, Office Action, page 4, item 6. The Office Action combines Wu and Morrell to conclude that “It would have been obvious to one of ordinary skill in the art to modify the substrate of Morrell to include a mask in order to protect the substrate an insulate pads as taught by Wu.” *See*, Office Action, page 4, item 8. Applicants respectfully disagree with this statement.

Morrell’s columnar interconnections 25 are taught to be bonded with Morrell’s substrate bond pads 32 not covered by any solder mask. Morrell’s columnar interconnections 25 have a small portion 34 made of solder at a bottom thereof. *See*, Morrell, Figure 3. Morrell’s design would avoid the solder 34 from flowing widely because Morrell’s solder 34 is seen to be a small volume and confined to the bottom of the metallic column 24. Therefore, one of ordinary skill in the art would not be motivated to form a solder mask covering the peripheries of Morrell’s substrate bond pads 32 to prevent Morrell’s solder 34 from flowing widely.

However, Wu’s bumps have a large portion of solder 90, as illustrated in Figs. 2F or 3E of Wu, different from Morrell’s design rules with a small volume of solder. Furthermore, Wu teaches that the solder bumps 90 are reflowed into solder balls 100. *See*, Wu, col. 8, lines 59-60. Wu’s solder mask 86 is motivated to be provided on a peripheral region of Wu’s I/O pad 82 to

confine such a flowing of Wu's solder 90. Accordingly, Wu's bumps 90 are designed with a significantly different mechanism from Morrell's columnar interconnections 25, and therefore, there is not a motivation to combine Wu's solder mask 86 with Morrell's device (e.g., as shown in Figs. 3 and 4 of Morrell). In this regard, neither of the applied references provide any suggestion or motivation to combine Wu's solder mask 86 with Morrell's structure. Applicants therefore respectfully submit that the Office Action has improperly combined Morrell and Wu in arriving at the rejection above.

Furthermore, the Office Action concludes that the tin containing cap 30 of Morrell, in combination with Ohuchi, teaches the "tin-containing layer" feature recited in Claim 92. *See*, Office Action, page 3, lines 15-16 and page 4, item 9. The Office Action states that "As for applicant's allegation of the inability to use Ohuchi, as previously stated, applicant's claims are products, and it is immaterial as to the process used to make the claims. Morrell' disclosure of its process, while they may be preferences, is not the sole mean by which to accomplish the particular task." *See*, Office Action, page 12, item 40.

Applicants respectfully disagree. Even though Claim 92 of the present application is a product claim, certain claim features having different materials, disclosed in different prior arts, formed by different processes cannot be readily replaced by each other. For example, Morrell teaches that before an integrated circuit component 12 is bonded to a substrate 14, an electroplating process is used to preform a solder cap 30, comprising tin and lead, over the integrated circuit component 12. *See*, Morrell, Figures 1 and 2. On the other hand, Ohuchi teaches that before a semiconductor device 6 is bonded to a substrate 1, a screen printing process is used to preform a solder 2 on the substrate 1, but not on the semiconductor device 6. *See*, Ohuchi, para. [0060] and Figures 3(a) to 3(f). Therefore, Ohuchi's solder 2 is believed not to be analogous to Morrell's solder cap 30 because Ohuchi's solder 2 and Morrell's solder cap 30 are formed in different ways and in different steps, as mentioned above. Ohuchi's solder of a tin-silver alloy is not taught to be formed by an electroplating process, but taught to be formed by a screen printing process. Therefore, one of ordinary skill in the art would not replace Morrell's electroplated solder cap 30 with Ohuchi's tin-silver-alloy solder 2. In this regard, there is no teaching or suggestion in Ohuchi that a tin-silver alloy can also be formed by an electroplating

process as suggested by Morrell for formation of the solder cap 30. Applicants therefore respectfully submit that the Office Action has improperly combined the applied references in rejecting the “tin-containing layer comprising silver” recited in Claim 92 of the present application.

Based on the above, Claim 92 is believed to be allowable over the applied references. Reconsideration and withdrawal of the rejections of Claim 92 are respectfully requested.

Claim 120

Claim 120 is directed to a bonding structure on a chip comprising a pad having a top surface with a first region, a second region and a third region between said first and second regions, and a separating layer on said first and second regions, wherein an opening in said separating layer is over said third region, and said third region is at a bottom of said opening. A metal layer is on said third region, over said separating layer and over said first and second regions, wherein said metal layer is connected to said third region through said opening. A copper pillar is on said metal layer, over said separating layer and over said first, second and third regions, wherein said copper pillar is connected to said third region through said metal layer. A tin-containing cap is over said copper pillar, wherein said tin-containing cap is connected to said copper pillar, wherein said tin-containing cap comprises silver, wherein said tin-containing cap has a first thickness less than a second thickness of said copper pillar.

Claim 120 is believed to be allowable over the applied references at least for the same reasons presented above with respect to the “tin-containing layer comprising silver” feature of Claim 92. Reconsideration and withdrawal of the rejections of Claim 120 are respectfully requested.

Claim 151

Claim 151 is directed to a bonding structure on a chip comprising a pad having a top surface with a first region, a second region and a third region between said first and second regions, and a separating layer on said first and second regions, wherein an opening in said separating layer is over said third region, and said third region is at a bottom of said opening. A metal layer is on said third region, over said separating layer and over said first and second

regions, wherein said metal layer is connected to said third region through said opening. A copper pillar is on said metal layer, over said separating layer and over said first, second and third regions, wherein said copper pillar is connected to said third region through said metal layer. A tin-containing cap is over said copper pillar, wherein said tin-containing cap is connected to said copper pillar, wherein said tin-containing cap has a first thickness less than a second thickness of said copper pillar, wherein said tin-containing cap has a width less than that of said copper pillar.

The Office Action argues that the transverse dimension feature of the tin-containing cap recited in Claim 151 is obvious in light of the applied references. *See*, Office Action, page 9, item 23. Without addressing or conceding the merits of this argument, it is respectfully submitted that Claim 151 has been amended to recite that “said tin-containing cap has a width less than that of said copper pillar,” which feature is believed not to be taught or suggested by Morrell.

Based on the above, Claim 151 is believed to be allowable over the applied references. Reconsideration and withdrawal of the rejections of Claim 151 are respectfully requested.

The other claims currently under consideration in the application are dependent from their respective independent claims discussed above and therefore are believed to be allowable over the applied references for at least similar reasons. Because each dependent claim is deemed to define an additional aspect of the invention, the individual consideration of each on its own merits is respectfully requested.

The absence of a reply to a specific rejection, issue, or comment does not signify agreement with or concession of that rejection, issue, or comment. In addition, because the arguments made above may not be exhaustive, there may be other reasons for patentability of any or all claims that have not been expressed. Finally, nothing in this paper should be construed as an intent to concede any issue with regard to any claim, except as specifically stated in this paper, and the amendment or cancellation of any claim does not necessarily signify concession of unpatentability of the claim prior to its amendment or cancellation.

CONCLUSION

In view of the remarks set forth herein, Applicants submit that the claims are in condition for allowance and respectfully request a notice to this effect. Should the Examiner have any questions, please contact the undersigned.

To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 502624 and please credit any excess fees to such deposit account.

Respectfully submitted,

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